

*Health Consultation*

**Evaluation of Contaminants: Domestic wells near  
Bainbridge Island Landfill  
(March 1999 Sampling Data)**

**Kitsap County, Washington**

**CERCLIS # WAD980978720**

August 1999

**Prepared by  
Washington State Department of Health  
Under Cooperative Agreement with the  
Agency for Toxic Substances and Disease Registry**

**FOREWORD**

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This Health Consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this Health Consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. The Health Consultation allows DOH to respond quickly to a request from concerned residents for health information on hazardous substance. It provides advice on specific public health issues. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

For additional information or questions regarding DOH, ATSDR, or the contents of this Health Consultation, please contact the preparer of this report:

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## **BACKGROUND AND STATEMENT OF ISSUES**

In the spring of 1998, the Washington State Department of Ecology (Ecology) asked the Washington State Department of Health (DOH) to evaluate potential short-term health threats from vinyl chloride and other contaminants detected in domestic water supply wells in the vicinity of the Bainbridge Island Landfill in Kitsap County, Washington. This health consultation is the fifth in a series of health consultations prepared by DOH which summarizes our evaluation of the public health implications resulting from actual or potential exposure to these contaminants. The four previous health consultations prepared by DOH evaluated and summarized the results of domestic well samples collected near the landfill between April 1996 and December 1998. DOH concluded that *no apparent public health hazard existed from exposure to contaminants detected in any of the wells during these sampling periods*. The no apparent public health hazard category is used for sites where human exposure to contaminated media (i.e., water) is occurring or has occurred in the past, but the exposure is below a level of health hazard.

As part of the ongoing Bainbridge Island Landfill Remedial Investigation (RI), during the March 1999 sampling event, the Kitsap County Department of Public Works collected water samples from nine monitoring wells at the landfill and 13 water supply wells located in the vicinity of the landfill to evaluate water quality. Water samples were also collected from the bathtub, kitchen tap, and/or shower of four residences on the Stetson Acres well (BOW37). A seep sample was also collected. DOH will continue to evaluate domestic well sampling data over the next few years to assure that concentrations remain at a safe level. If concentrations should increase to levels that could threaten public health, DOH or the Bremerton-Kitsap County Health District will notify well users immediately.

For more detailed information about the Landfill investigation, the reader can refer to the RI report for the Bainbridge Island Landfill.

## **METHODS**

The reader can refer to the previous DOH health consultations for a detailed description of the methods used by DOH to evaluate data.

## **DATA SUMMARY**

A total of 13 domestic wells were sampled by the Kitsap County Department of Public Works during the March 1999 sampling event. Sampling analysis included VOCs and conventionals (total organic carbon, temperature, nitrate, pH, alkalinity, chloride, total dissolved solids, dissolved oxygen, sulfate, etc.) for all 13 wells. No other chemical groups were analyzed during the March 1999 sampling event.

Eight VOCs were detected at low levels during the March sampling round, although vinyl chloride was the only one which slightly exceeded an ATSDR screening value. Contaminants detected below ATSDR screening values are unlikely to pose a public health threat and will not be discussed further in the health consultation. Table 1 lists the domestic wells with the single highest chemical detections, each chemical's health-based screening value, well ID, and

approximate number of residences served by the well, Table 2 lists vinyl chloride concentrations in well BOW37 during the March 1999 sampling event. Table 3 lists the vinyl chloride concentrations at the well BOW37 wellhead from 1996 to the present.

**TABLE 1**  
**DOMESTIC WELL CONTAMINANTS**  
**(MARCH 1999 SAMPLING RESULTS)**

Chemical/Analyte	Highest Concentration (µg/l)	Carcinogenic Screening Value (µg/l)	Non-carcinogenic Screening Value (µg/l)	Well ID	Number of Residences Served
N-Nitrate	2,600	NA	10,000 (SDWA MCL)	BOW84	
Dichlorodifluoromethane	1.9	NA	2,000 (child RMEG) 1,000 (adult LTHA)	BOW33	
<i>Vinyl chloride</i> ☆	<b>0.165</b> <i>Resident #3 shower</i>	0.02 (MTCA B)	0.2 (child chronic EMEG) 0.7 (adult chronic EMEG)	BOW37	6
<i>Vinyl chloride</i> ☆	<b>0.26 (wellhead)</b>	0.02 (MTCA B)	0.2 (child chronic EMEG) 0.7 (adult chronic EMEG)	BOW37	6
1,1-Dichloroethane	0.2 J	NA	800 (MTCA B)	BOW37	6
2-butanone (MEK)	2.8	NA	6,000 (child RMEG)	BOW37	6
acetone	3.8	NA	1,000 (child RMEG)	BOW37	6
chloromethane	0.2	3 (LTHA)	NA	BOW98	
methylene chloride	0.4	5 (CREG)	600 (Child RMEG)	BOW37	6
1,1-Dichloroethene	0.03	0.06 (CREG)	90 (child RMEG)	BOW09	

µg/l = micrograms of chemical per liter of water (equals one part per billion)

CREG = ATSDR's Cancer Risk Evaluation Guide

RMEG = ATSDR's Reference Dose Media Evaluation Guide

LTHA - EPA's Lifetime Health Advisory for Drinking Water

MTCA B = WA Model Toxics Control Act Method B groundwater cleanup level

NA = Not available

EMEG = ATSDR's Environmental Media Evaluation Guide

J = estimated value between the calculated detection limit and reporting limit

**bolded/italicized** compounds = compounds exceeding one or more screening value which required further evaluation

☆ - This was the only vinyl chloride detection in a domestic well during the 3/99 sampling event

**TABLE 2**  
**VINYL CHLORIDE CONCENTRATIONS**  
**WELL BOW37**

**MARCH 19, 1999**

<b>Resident Number</b>	<b>Sample Location</b>	<b>Concentration (µg/l)</b>	<b>Carcinogenic Screening Value (µg/l)</b>	<b>Non-carcinogenic Screening Value (µg/l)</b>
1	Bathtub	0.11	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
1	Kitchen Tap	0.07	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
1	BOW37 Wellhead	0.26	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
2	Shower	0.07	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
2	Kitchen Tap	0.01	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
2	BOW37 Wellhead	0.26	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
3	Shower	0.165	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
3	Kitchen Tap	0.14	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
3	BOW37 Wellhead	0.26	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
4	Shower	0.05	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
4	Kitchen Tap	0.13	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)
4	BOW37 Wellhead	0.26	0.02 (MTCA B)	0.2 (child chronic EMEG); 0.7 (adult chronic EMEG)

**TABLE 3**  
**VINYL CHLORIDE CONCENTRATIONS**

**WELL BOW37 WELLHEAD  
SEPTEMBER 1996-MARCH 1999**

<b>Sample Collection Date</b>	<b>Concentration (µg/l)</b>
September 1996	0.63
October 1996	0.77
April 1997	0.53
June 1997	0.32
September 1997	0.3
December 1997	0.38
March 1998	0.43
June 1998	0.39
September 1998	0.36
December 1998	0.35
March 1999	0.26

**Discussion**

After evaluating all of the March sampling data, *DOH concluded that no health threat exists for people exposed for 1-5 years (chronic exposure) to any of the contaminants detected in the domestic wells. A slight increase in lifetime cancer risk exists from exposure to the maximum concentration of vinyl chloride in well BOW37.* There is no apparent public health hazard. ATSDR uses the “*no apparent public health hazard*” category for sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

#### Contaminants exceeding a screening value which were further evaluated:

The following contaminant detected in an individual domestic well exceeded an ATSDR health-based screening value and was further evaluated in the health consultation:

### **Vinyl Chloride**

The maximum vinyl chloride concentration detected at the point of exposure was from the BOW37 resident # 3 shower sample (0.165 µg/l). Well BOW37 is located approximately 800 feet northeast of the landfill.

Vinyl chloride is a colorless gas at normal temperatures. All vinyl chloride is manufactured or results from the breakdown of manufactured substances, such as trichloroethylene, trichloroethane, and tetrachloroethylene (commonly used cleaning and degreasing compounds). Most of the vinyl chloride produced in the United States is used to make polyvinyl chloride (PVC). PVC is used to make a variety of plastic products including pipes, wire, cable coatings and packaging materials. Other uses include furniture and automobile upholstery, wall coverings, housewares, and automotive parts.

#### Non-cancer health effects

Short-term health effects may include damage to the nervous system. Breathing high levels (>1,000 ppm) of vinyl chloride can cause dizziness and sleepiness. Animal studies have demonstrated that exposure to extremely high levels of vinyl chloride can damage the liver, lungs, and kidneys. Other animal studies suggest that long-term inhalation exposure to vinyl chloride may damage the sperm and testes and cause high blood pressure during pregnancy. Studies using pregnant animals show that breathing high levels (2-500 ppm) of vinyl chloride may harm their unborn offspring. Animal studies also show that vinyl chloride may cause increased numbers of miscarriages early in pregnancy. It may also cause decreased weight and delayed skeletal development in fetuses. The effects of drinking high levels of vinyl chloride are unknown. The MRL was derived from a LOAEL value of 0.018 mg/kg/day for an increased incidence of areas of cellular alteration in the livers of rats. Assuming long-term ingestion and inhalation exposure to the maximum detected indoor concentration of vinyl chloride (0.165 µg/l at resident 3 shower), the estimated exposure dose is one half the chronic duration MRL and nearly 2,000 times lower than the LOAEL, indicating that non-cancer health effects would not be expected.

#### Cancer effects

Results from several studies suggest that breathing air or drinking water containing low levels of vinyl chloride may increase the risk of developing cancer. Hepatic angiosarcomas in Sprague-Dawley rats were observed at doses thousands of times greater than the dose estimated for persons chronically exposed to the March 1999 vinyl chloride concentration in well BOW37. Studies of workers who have been exposed to vinyl chloride over many years also indicate increased incidences of angiosarcoma of the liver. Brain, lung, and some blood cancers may also be attributed to chronic inhalation exposure to vinyl chloride. Studies of long-term exposure in rats indicate that increases in liver and mammary gland cancer may occur at very low levels of exposure in the air (5-250 ppm). The Department of Health and Human Services, International Agency for Research on Cancer, and EPA have determined that vinyl chloride is a human carcinogen.

EPA and the World Health Organization's International Program for Chemical Safety have been reevaluating vinyl chloride since the 1980's. Because of the reevaluation, EPA has removed the oral slope factor. Another peer review panel was scheduled to meet in the spring of 1999 to attempt to achieve consensus on quantifying vinyl chloride's risk. For this health consultation, the former oral slope factor of 1.9 was used to estimate the additional lifetime cancer risk from exposure to vinyl chloride.

The estimated increased cancer risk, assuming chronic exposure to the maximum concentration (0.165µg/l) of vinyl chloride in drinking water from well BOW37, is slightly increased; approximately seven additional cancers in a population of 1,000,000 persons exposed for thirty years, averaged over a 70 year lifetime.<sup>1</sup>

## **Child Health and Developmental Effects**

### *Vinyl chloride*

Upon review of the scientific literature, no human or animal studies were located regarding developmental or reproductive effects following oral exposure to vinyl chloride. However, some data suggests that fetuses, infants, and young children may be particularly susceptible to the toxic effects of vinyl chloride. Vinyl chloride can cross the placenta and enter the blood of fetuses. Developmental effects have been observed as a result of parental exposures to vinyl chloride *in the air*. A statistically significant increase in birth defects was observed in three cities in which facilities using vinyl chloride were located when compared to statewide and county wide averages. The greatest increases were malformations of the central nervous system, upper digestive tract, genital organs, and in the incidence of club foot. However, the levels at which these effects were observed were much higher than levels expected to result from volatilization of vinyl chloride from residential tap water usage or shower from showering.

Results of animal inhalation studies indicate that vinyl chloride produces developmental effects at concentrations that are also toxic to maternal animals. Maternal toxicity was evidenced by

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<sup>1</sup> A review of Health District records indicate that BOW37 was initially drilled as a private well in 1976. County Assessor records indicate that homes were built and connected to the water supply in 1983, 1986, and the mid 1990s. As a result, estimated exposures, and thus risk, would be even less than this since a 30-year exposure duration was assumed for this health consultation.

decreased food consumption, decreased body weight, and increased mortality. Delayed ossification was noted in fetuses at 500 ppm. Vinyl chloride exposed rats throughout gestation showed an increased incidence of hemorrhages, increased edema, decreased hemoglobin and leukocytes and decreased organ weights. However, doses at which developmental effects were observed were several orders of magnitude higher than estimated doses resulting from exposure to vinyl chloride from well BOW37.

## Conclusions

1. No health threat exists for people exposed for 1-5 years (chronically) to concentrations of contaminants detected in any of the domestic wells sampled to date, although there is a slight increase in the cancer risk for people exposed to vinyl chloride over a 30 year period.
2. Based on DOH's evaluation of all of the domestic well data provided to date, *no apparent public health hazard exists as a result of exposure to contaminants detected in any of the wells.*

## Recommendations

1. Continue quarterly monitoring of domestic wells. Provide DOH with the results of the quarterly monitoring for review and evaluation.

### Actions

- DOH has completed five health consultations evaluating results of quarterly domestic well samples collected from April 1996 - March 1998, for June 1998, for September 1998, for December 1998, and for March 1999. Quarterly monitoring continues, and Kitsap County Department of Public Works will submit the sampling results to DOH for review and evaluation. Health consultations will be prepared for subsequent sampling events over the next few years.
2. Well BOW37 should be monitored to observe that the concentrations of volatile organic compounds, such as vinyl chloride, do not increase in subsequent sampling events. If vinyl chloride (or other VOCs) show increasing trends or reach federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs), exposures should be reduced or eliminated (options could include treatment or an alternate water source). DOH will continue to review and evaluate quarterly well monitoring results to determine future recommendations.

### Actions

- Well BOW37 has been sampled and evaluated, and the owner notified of the results. This well has consistently shown the highest and most frequent vinyl chloride detections and continues to be monitored quarterly for VOCs and conventional parameters.
3. Ecology's March 1995 and March 1998 letters recommending that the Bremerton/Kitsap County Health District limit its well site approval in the areas identified in the vicinity of the landfill should be adhered to.

#### Actions

➤ Bremerton/Kitsap County Health District is adhering to Ecology's recommendations.

4. Should future public health intervention become necessary, DOH will work with the appropriate agencies to address the possible long-term need for an alternate water source or treatment for wells determined to be at risk.

#### Actions

➤ Thus far, contaminant concentrations and trends have not warranted alternate water supplies (Table 3). However, DOH continues to evaluate monitoring results and will work with the appropriate agencies to address treatment options or alternate water supplies should they become necessary.

5. DOH is available to review and evaluate the results of any water samples the Bremerton/Kitsap County Health District or area residents may decide to collect from the domestic wells dropped from the Bainbridge Island landfill investigation.

## CERTIFICATION

This Health Consultation for the Bainbridge Island Landfill Area Site was prepared by the Washington Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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Technical Project Officer  
Superfund Site Assessment Branch (SSAB)  
Division of Health Assessment and Consultation (DHAC)  
ATSDR

The Division of Health Assessment and Consultation, ATSDR has reviewed this health consultation, and concurs with its findings.

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Richard Gillig  
Section Chief, SSAB, DHAC, ATSDR

## **Appendix A - Exposure assumptions**

For this health consultation, it was assumed that residents were exposed 350 days per year, for thirty years to the contaminant concentrations highlighted in Table 1. This exposure duration was intended to account for potential past and future exposures, as well as current exposure. Exposure was assumed to be 2 liters of water per day and was assumed to occur through ingestion (drinking) and non-ingestion (inhalation and dermal contact) routes. Non-ingestion exposures are assumed to occur during household activities such as cooking, bathing, and dishwashing.

## **Appendix B-Exposure formulas**

It is assumed that non-ingestion (inhalation and dermal) exposures are equal to exposures through ingestion.

$$\text{Exposure dose} = [(C \times IR \times EF \times ED)/BW \times AT)] \times 2$$

$$\text{Additional lifetime cancer risk} = \text{Estimated exposure dose} \times \text{CSF}$$

where:

C = concentration of contaminant (µg/l)

IR = Ingestion rate (liters of water/day)

EF = Exposure frequency (days/year)

ED = exposure duration (total # of years in exposure period)

BW = body weight

AT = averaging time (70 years x 365 days/year)

CSF = Cancer slope factor (Estimates the excess upperbound lifetime probability of an individual developing cancer from an exposure)

## References

1. Bainbridge Island Landfill Validated Data Set for First Quarter 1999; CH2M Hill, June 8, 1999.
2. Integrated Risk Information System (IRIS), June 1999.
3. ATSDR Health Consultation Procedures, Agency for Toxic Substances and Disease Registry, May 1995.
4. Toxicological Profile for Vinyl Chloride, U.S. Department of Health and Human Services, Public Health Service, ATSDR, September 1997.
5. Conversations with Barbara Trejo and Brian Sato, Washington State Department of Ecology, 1999.
6. American Cancer Society: Facts and Figures: 1998 Cancer statistics.

## GLOSSARY

**EMEG:** ATSDR's Environmental Media Evaluation Guide. A concentration in air, soil, or water (or other environmental media), which is derived from ATSDR's MRL, and below which adverse non-cancer health effects are not expected to occur. Separate EMEGs can be derived to account for acute, intermediate, or chronic exposure durations.

**RMEG:** ATSDR's Reference Dose Media Evaluation Guide. A concentration in air, soil, or water (or other environmental media), which is derived from EPA's RfD, and below which adverse non-cancer health effects are not expected to occur. RMEGs account only for chronic exposure.

**MRL:** ATSDR's Minimal Risk Level. An estimate of daily human exposure to a dose of chemical that is likely to be without an appreciable risk of adverse noncancerous health effects over a specified duration of exposure. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration via a given route of exposure. MRLs can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

**CANCER SLOPE FACTOR:** A plausible upperbound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upperbound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

**LOAEL:** Lowest Observed Adverse Effect Level. LOAEL's have been classified into "less serious" or "serious" effects. In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

**MCL:** Federal Maximum Contaminant Level. A drinking water regulation established by the Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.

**CARCINOGEN:** Any substance that can cause or contribute to the production of cancer.

**CONTAMINANT:** Any substance or material that enters a system (the environment, human body, food, etc.) where it is not normally found.

**MONITORING WELLS:** Wells developed to collect groundwater samples for the purpose of physical, chemical, or biological analysis to determine the amounts, types, and distribution of contaminants.

**MTCA:** Model Toxics Control Act. Washington States hazardous waste cleanup law.

## **FIGURES**

Figure 1: Bainbridge Island Landfill Site Location Map

Figure 2: Bainbridge Island Landfill Regional Topography and Surface Water Drainages

Figure 3: Bainbridge Island Landfill Offsite Domestic Wells